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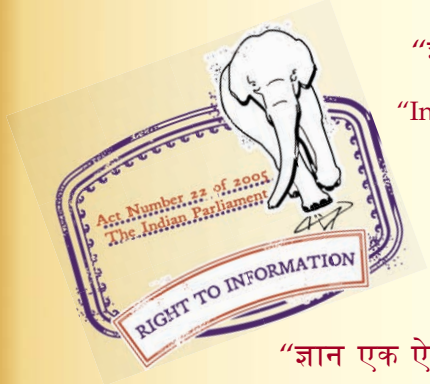
IS 1118 (1992): gear lubricants, multipurpose (extreme pressure gear oil) [PCD 3: Petroleum, Lubricants and their Related Products]



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Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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भारतीय मानक

बहुधंधी गियर स्नेहक (अति दाब गियर तेल) – विशिष्टि

(पहला पुनरीक्षण)

Indian Standard

GEAR LUBRICANTS, MULTIPURPOSE (EXTREME PRESSURE GEAR OIL) — SPECIFICATION

(First Revision)

First Reprint OCTOBER 1994

UDC 621·892·093 : 621·833

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

September 1992

Price Group 6

AMENDMENT NO. 1 SEPTEMBER 2007
TO
IS 1118 : 1992 GEAR LUBRICANTS, MULTIPURPOSE (EXTREME PRESSURE GEAR OIL) — SPECIFICATION

(First Revision)

(*Page* 3, *clause* **4.3.1.1**) — Substitute 'Amsler' *for* 'Ansler'.

(*Page* 6, *Annex* A, *clause* **A-3.3**) — Substitute the following for the existing:

'**Container** — Flat bottom, approximately 90 mm ID × 110 mm high, with 25 mm (minimum) legs, and with cover to support thermometer in centre and steel strip at side of container (see Fig. 1).'

(*Page* 6, *Annex* A, *clause* **A-3.5**, *line* 3) — Substitute '30 mm' *for* '30 cm'.

[*Page* 6, *Annex* A, *clause* **A-4.1**(a), *line* 1] — Substitute '13 mm' *for* '13 cm'.

(*Page* 12, *Fig.* 1) — Substitute '25 mm (MIN)' *for* '2.5 cm (MIN)'.

(PCD 3)

Reprography Unit, BIS, New Delhi, India

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Lubricants and Related Products Sectional Committee had been approved by Petroleum, Coal and Related Products Division Council.

This standard was originally published in 1957 covering Gear Lubricants based on the prevailing U. S. Military Specification MIL-L-2105 and the U. K. Military of Supply Specification CS 2758. In the last three decades considerable changes have taken place in the consumer demand with respect to the lubricant performance levels. The present revision is based on a review of these developments.

The oils under this specification are classified as extreme pressure (EP) oils under the following two different types, each of which approximately corresponds in performance to the respective overseas military and/or industry specifiation as indicated below:

Type	*Equivalant Performance*
EP Type GL-4	MIL-L-2105B/API-GL-4/CS : 3000 A
EP Type GL-5	MIL-L-2105D/API-GL-5/CS : 3000 B

Performance test facilities for qualifying EP type GL-4 and EP type GL-5 oils are not presently available in India. For the purpose of qualifying oils against EP type GL-5, facilities available in the approved overseas laboratories are expected to be utilized till such time these or equivelent tests are established in the country. But in the case of EP type GL-4 oils, testing facilities are not available even In overseas. For qualifying these oils indigenous performance tests have been included, the test facilities for which have been made available with Indian Institute of Petrolium Dehra Dun; Indian Oil Corporation Ltd (R & D Centre), Faridabad and Lubrizol (India) Ltd. (R & D Centre), Thane respectively (*see* **4.3.1**). However, for guaranteeing the quality, only oils with at least half the dosage of the GL-5 approved additive package has been allowed. Further, for the evaluation of shock loading tendency of EP-type GL-4 gear oils Amsler test as developed by Indian Institute of Petroleum, Dehra Dun (VAV-382/IIP Method) has been included as an alternate performance test to LFW ring test. The committee also felt it to include at a later date the recommendation made based on the review of the data generated on Amsler rig test. [Details of these test methods namely VAV-382/IIP Method and the LFW-1 rig test have, however, not been included in the standard; the test facilities are available with Institute of Petroleum, Dehra Dun and (R & D) Centre, Faridabad respectively.] Indian Standard for the approved performance test 'Shell Four Ball EP Test' of EP type GL-4 gear oil is yet to be formulated. Till such time, the test shall be carried out in accordance with IP-239/85 published by Institute of Petroleum,London (*see* **4.3.1.1**). Indian Standards for the laboratory performance tests for EP type GL-5 gear oils have not yet been formulated. Till such time the standards are formulated the test methods ASTM STP 512 AL-33, L-37, L-42 and L-60 published by American Society for Testing and Materials (USA) shall be followed (*see* **4.3.2**). These oils are to be tested for ASTM STP 512 A L-33, L-37, L-42 and L-60 performance tests in any of the approved laboratories after abtaining guidance from the Qualifying Panel.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard
GEAR LUBRICANTS, MULTIPURPOSE (EXTREME PRESSURE GEAR OIL) — SPECIFICATION
(First Revision)

1 SCOPE

1.1 This standard prescribes the requirements and methods of sampling and test for the various types of multipurpose automotive gear lubricating oils [extreme pressure (EP) type].

1.2 The lubricant is primarily intended for use in automotive hypoid gear units, manual transmissions, final drives, steering gears and fluid lubricated universal joints of automotive equipment.

1.3 This standard may involve hazardous materials, operations and equipments. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2 NORMATIVE REFERENCES

The following standards contain provisions which through reference in this text, constitute provisions of the standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standards are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
1447 : 1966	Methods of sampling of petroleum and its products
1448	Methods of tests for petroleum and its products

3 CLASSIFICATION

3.1 Types

The oils qualifying this standard shall be classified as Extreme Pressure (EP) oils under one of the following two types:

i) EP type GL-4

ii) EP type GL-5

3.2 Viscosity Grade

The oils shall conform to one of the following six mono-viscosity grades as distinguished by the prescribed viscosity limits given in Table 1:

i)	SAE	75	W
ii)	SAE	80	W
iii)	SAE	85	W
iv)	SAE	90	
v)	SAE	140	
vi)	SAE	250	

3.3 The oils may also be multi grade combination of a 'W' grade with another monograde component, for example, 75 W-90, 80 W-90, 85 W-140, etc. In such a case oil shall comply with the requirements of the 'W' grade component in full as also the viscosity at 100°C of other component grade.

3.4 Approved Performance Tests

The tests for performance evaluation of oils are summarized below:

Type of Oil	*Approved Performance Tests*
EP type GL-4	i) Shell four ball rig test ii) LFW-1 rig test/Amsler rig test
EP type GL-5	i) L-33 test ii) L-60 test iii) L-37 test iv) L-42 test

4 REQUIREMENTS

4.1 General

The gear lubricating oils shall be homogeneous and shall be formulated using mineral lubricating oil base stock (virgin or re-refined or combination thereof), a synthetically prepared product, or a combination of the two types of products compounded with such functional additive materials like viscosity index improvers, pour point depressants, oxidation and corrosion inhibitors, extreme pressure agents, antiwear additives, antifoamants, etc, as are necessary to meet the specified requirements of this standard.

4.2 Physico-Chemical Requirements

4.2.1 *Requirements for Finished Oil*

The oil shall be free from suspended matter, grit, water or any other impurities. The oil shall also comply with physico-chemical requirements prescribed in Table 1 and 4.2.2 and 4.2.3.

Table 1 Physico-Chemical Requirements of Gear Lubricant, Multipurpose, EP Types GL-4 and GL-5

(*Clauses* 3.2 *and* 4.2.1)

Sl No.	Characteristic	Requirements for Grade						Methods of Tests, Ref to	
		SAE 75W	SAE 80W	SAE 85W	SAE 90	SAE 140	SAE 250	Annex	IS 1448
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	Appearance	When examined in transmitted light in a colourless glass test tube of 25 mm internal diameter, the oil shall be clear, bright and free from turbidity and sediment						—	—
ii)	Kinematic viscosity, Cst at 100°C	4.1, *Min*	7.0, *Min*	11.0, *Min*	13.5 to 24.0	24.0 to 41.0	41.0, *Min*	—	P : 25
iii)	Maximum temperature for Brookfield viscosity of 150 000 CP, °C	−40	−26	−12	—	—	—	—	P : *
iv)	Viscosity index, *Min*	85	85	85	85	80	80	—	P : 56
v)	Flash point, °C (Cleveland open cup), *Min*	150	165	180	180	190	200	—	P : 69
vi)	Channel point, °C	Pass at −45	Pass at −35	Pass at −20	Pass at −18	Pass at −7	Pass at 0	A	—
vii)	Copper strip corrosion, *Max*							—	P : 15
	a) Max/EP type GL-4 121°C for 1h	..... Not worse than No. 2							
	b) EP type GL-5 121°C for 3h	..... Not worse than No. 3							
viii)	Foaming characteristics/tendency/stability							—	P : 67
	a) at 24°C, *Max*	..... 300/Nil							
	b) at 93.5°C, *Max*	..... 50/Nil							
	c) at 24°C after the test at 93.5°C, *Max*	..... 300/Nil							

*Under preparation. Till such time ASTM D 2983-87 shall be followed.

4.2.2 *Stability and Compatibility of Finished Lubricating Oils*

4.2.2.1 The finished blended oil shall have the additive elements uniformly distributed throughout the oil and shall show no evidence of instability at temperature specified in the homogeneity and miscibility test described in Annex B.

4.2.2.2 The oil shall be compatible with all other oils previously qualified under this standard as demonstrated by the compatibility test described in Annex C. The compatibility is determined by subjecting separate mixtures of the oil with six selected reference oils designated by Qualifying Authority.

4.2.3 *Storage Stability*

The oil shall satisfactorily pass the storage stability test as described in Annex D.

4.2.4 *Requirements of the Base-Stock*

4.2.4.1 The maximum viscosity-index of the base-stock used in formulating the gear oil shall be not less than 85.

4.2.4.2 Each base-stock component used in formulating the finished oil shall be accompanied by the following property data:

Properties to be reported:

i) Kinematic viscosity at 40°C and 100°C in Cst;
ii) Viscosity index;
iii) Flash point, °C;
iv) Conradson carbon residue, percent by mass;
v) Sulphated ash, percent by mass;
vi) Water content, percent by volume;
vii) Total acid number;
viii) Pour point, °C;
ix) Sulphur content, percent by mass; and
x) Colour.

4.3 Performance Test Requirements

4.3.1 *EP Type GL-4 Oils*

This type of oil shall be formulated only with an additive system on which an approval of API GL-5 level already exists. To guarantee the quality in the absence of approved axle tests, half of the GL-5 dosage has been kept minimum as additive concentration and shall meet the limits of Amsler rig test, LFW-1 rig test and shell four-ball tests as specified in **4.3.1.1**, **4.3.1.2** and **4.3.1.3**.

4.3.1.1 *Ansler rig test (VAV-382/IIP Method)*

A sample of lubricant is fed through the rotating steel disc dipped in the lubricant bath thermostatically controlled into the contact zone of EN-31 Steel-Steel disc combination rotating each other in double sliding mode under prescribed loading-unloading cycle. The loading at which the scuffing occurs form the criteria for examining the shock loading characteristics of the oils. This test is done on Amsler Type A 135 disc machine. The test pieces are two discs made of EN-31 steel which rotate in the same direction. The low disc dips in the test oil bath.

The gear oils of EP type GL-4 shall be qualified if scuffing load lies within 60 ± 10 kg.

4.3.1.2 *LFW-1 rig test*

Lubricant, Friction and Wear (LFW-1) is Falex-Block-on-Ring test machine. Antiscore properties of automotive gear oils can be screened on this test rig. The gear oils of EP type GL-4 shall be qualified if wear scar depth and width is within ±10 percent of the reference oil AGO-1 when tested under the following conditions:

Load	:	136 kg at the specimen
Speed	:	800 rpm
Oil temperature	:	130 ± 1°C
Test duration	:	10 minutes
Gear oil grade	:	SAE 90

Details of reference fluid AGO 1 are described in Table 2.

Table 2 Physico-Chemical Characteristics of Reference Oil AGO-1

Sl No.	Characteristics	Results
i)	Kinematic viscosity, Cst	
	a) at 40°C	190
	b) at 100°C	17
ii)	Viscosity index	95
iii)	Pour point, °C	−9
iv)	Flash point (COC), °C	200
v)	Phosphorus, percent by mass	0.05
vi)	Channelling at − 18°C	Non-channelling

4.3.1.3 *Shell four-ball EP test*

This is a very commonly used test rig in oil development programme. It consists of three 12.7 mm balls of EN-31 steel clamped in contact as in an equilateral triangle. The fourth ball is held in rotating chuck and touches each of the stationary balls. Load is applied through a lever system which pushes the three stationary balls upward against the rotating ball. The test lubricant covers the stationary balls. Tests are run at various loads for a specified period of time.

Gear oils of EP type GL-4 shall be qualified, if the weld load obtained is 280 kg.

4.3.2 *EP-Type GL-5 Oils*

4.3.2.1 *L-33 test (moisture corrosion)*

This test method is used for evaluating the rust and

corrosion inhibiting properties of a gear lubricant when subjected to water contamination and elevated temperature in a bench-mounted hypoid differential housing (carrier) assembly. It simulates a type of severe field service in which corrosion-promoting moisture in the form of condensed water vapour has accumulated in the axle assembly. This may happen as a result of volume expansion and contraction of the axle lubricant and the accompanied "breathing in" of moisture laden air through the axle vent. The customary test is a seven-day test; and abbreviated test of one day may also be run. At the end of the test the differential assembly is disassembled and rated for rust and corrosion, sludge and other deposits.

The oil shall prevent or minimize corrosion to gear unit components in the presence of moisture. Satisfactory performance shall be demonstrated when the oil exhibits test results of one percent or less on the test cover plate and no rust on gear teeth, bearings and functional components.

4.3.2.2 *L-60 test (thermal oxidation stability)*

This method is used for determining the deterioration of gear lubricant when subjected to severe thermal oxidation conditions. A sample of gear lubricant is placed in a heated gear box in which two spur gears and a test bearing are operating at a predetermined load in the presence of a copper catalyst. The temperature of the lubricant is maintained at 163°C while bubbling 1.1 l/h of oil through oil in the gear box for a test duration of 50 h of continuous operations. At the end of the test percent viscosity increase, *n*-pentane and toluene insolubles, etc, of the test lubricant are noted.

The oil shall resist thermal and chemical oxidation. Satisfactory performance shall be demonstrated when the oil exhibits test results of not more than 100 percent increase in lubricant viscosity, *n*-pentane insolubles not more than 3 percent by mass and toluene insolubles not more than 2 percent by mass.

4.3.2.3 *L-42 test (gear scoring)*

This method is used for determining the antiscoring properties of gear lubricants under high speed and shock conditions. The test unit consists of a spicer rear axle, ring pinion ratio 45:11, uncoated gears. The test unit with the test lubricant is operated under high speed conditions and under shock (peak torque) conditions.

At the completion of the test the pinion and ring gear are removed from the unit and rated on both drive and coast sides for percent of the contact area exhibiting scoring. The percent scoring for the test oil is compared to the percent scoring for the two reference oils.

Satisfactory performance shall be demonstrated when the oil tested in duplicate exhibits scoring less than or equal to reference oil RGO 110-90 under conditions of high-speed and shock loading.

4.3.2.4 *L-37 test (gear distress and deposits)*

This method is used for evaluating the load-carrying, wear and extreme pressure properties of a gear lubricant in an axle under conditions of high speed, low-torque and of low-speed, high-torque operation. It simulates a type of severe field service in terms of hypoid gear tooth loading and sliding velocities. It uses a hypoid differential housing (carrier) assembly, 5.86 ratio, standard differential with uncoated drive gear and drive pinion (ring and pinion); coated (manganese phosphate coating) drive gear and drive pinion may also be used. At the completion of the test under conditions of high speed low-torque operation (100 min at 440 wheel rpm and 535 N.m torque per wheel) and low-speed high torque operations (24 h at 80 wheel rpm and 2.35 kN.m torque per wheel) the ring and pinion are removed and rated for various forms of gear distress.

Satisfactory performance shall be demonstrated when the oil tested using untreated and phosphate-treated gear assemblies prevents gear tooth ridging, rippling, pitting, welding and excessive wear or other surface distress and objectionable deposits and does not produce excessive wear pitting or corrosion of bearing rollers, races or thrust washers under conditions of high-speed low-torque and low-speed high torque.

5 QUALIFICATION APPROVAL

The oil shall be subjected to qualification approval in accordance with the details given in Annex E.

6 PRODUCT IDENTIFICATION

To ensure acceptance of only qualified products and for the purpose of product identifying, tests may be carried out by the purchaser or his agency on the characteristics of the oil and the test results shall be compared with the corresponding figures given in the product identification report. Permissible tolerances of test results are indicated against each of the characteristics (*see* Table 3).

7 PACKING AND MARKING

7.1 Packing

The material shall be packed in metal containers or in any other suitable containers as agreed to between the purchaser and the supplier.

7.2 Marking

The containers shall be securely closed and marked with the following information:

a) Indication of the source of manufacture, recognized trade-mark, if any;
b) Name, type and grade of the material;
c) Net mass of the material; and
d) Identification in code or batch number or otherwise to enable the lot of consignment or manufacture to be traced back from records.

Table 3 Permissible Tolerances for Qualification

(Clause 6)

Sl No.	Characteristic	Tolerance	Methods of Test, Ref to	
			Annex	IS 1448
i)	Relative density	To be reported	—	P : 16
ii)	Flash point, °C (COC)	*Minimum* as specified	—	P : 69
iii)	Channel point, °C	*Maximum* as specified	A	—
iv)	Temperature for Brookfield viscosity of 150 000 cp, °C	-do-	—	P :*
v)	Kinematic viscosity, cst at 100°C	*Within the range* specified	—	P : 25
vi)	Viscosity index	*Minimum* as specified	—	P : 56
vii)	Sulphur, percent by mass	± 20 percent	—	P : 33
viii)	Phosphorus, percent by mass	-do-	—	P : 54
ix)	Chlorine, percent by mass	-do-	—	P : 50
x)	Zinc, percent by mass	-do-	—	P : 77

* Under preparation. Till such time ASTM D 2983-87 shall be followed.

7.2.1 All markings including batch number or lot of manufacture shall be made on one flat end when the material is packed in barrels.

7.2.2 The containers may also be marked with the Standard Mark.

8 SAMPLING

8.1 Representative samples of the material shall be drawn as prescribed in IS 1447 : 1966.

8.2 Number of Tests

Tests for all the characteristics given in Tables 1 and 5 of the specification shall be conducted on the composite sample.

8.3 Criteria for Conformity

The lot shall be declared as conforming to the requirements of the specification if all the test results on the composite sample satisfy the relevant specification requirements.

ANNEX A

[*Table* 1, *Item* (vi)]

DETERMINATION OF CHANNELING CHARACTERISTICS OF LUBRICANTS

A-1 SUMMARY

The test consists of storing the sample for 18 hours at the temperature required by the specification, cutting a channel in the lubricants with a metal strip, and determining whether the lubricant flows together to cover the bottom of the container within 10 seconds.

A-2 SAMPLE SIZE

Approximately 650 ml of lubricant to be tested.

A-3 APPARATUS

A-3.1 Steel Strip — square end (channeling tool), approximately 3 mm × 20 mm × 230 mm.

A-3.2 Thermometer — (H.B. Instrument Co., No. 22360 or equivalent)

A-3.3 Container — flat bottom, approximately 90 cm ID by 110 cm high, with 25 cm (minimum) legs, and with cover to support thermometer in centre and steel strip at side of container (*see* Fig. 1).

A-3.4 Heating Bath — 46° to 48°C.

A-3.5 Cooling Bath (non-liquid) — capable of maintaining the specified temperature within 1°C, size sufficient to accommodate container within 30 cm (minimum) clearance on all sides.

A-4 PROCEDURE

A-4.1 Prepare test set up as follows:

a) Fill container to within 13 cm of top with specimen, place in heating bath, and allow sample to reach 46°C. (If a liquid bath is used, adjust bath level to height of sample.)

b) When sample reaches 46°C, cover container and remove from bath, allow the samples to cool to 22 ± 1°C.

c) Position the thermometer so that the bulb is just below the surface. Insert the steel strip into the slit in the cover so that it is in a vertical position in contact with the wall of the container, with the end resting on the bottom of the container. Immediately place the sample in the cooling bath.

A-4.2 Store container in cooling bath without interruption for 18 ± 2 hours. Begin timing the storage period immediately after placing the sample in the cooling bath.

A-4.3 At the end of storage period, remove container from cooling bath, and within 30 seconds cut a sample as follows:

a) Check sample temperature and make sure that it is within ± 1°C of specified storage temperature.

b) Without moving steel strip, remove cover and thermometer from container.

c) Note time to nearest second, and within 5 seconds scrape the vertically held steel strip all the way across bottom of container.

A-4.4 Within 10 seconds after cutting the channel (*see* **A-4.3**), check to determine whether sample has flowed back and completely covered bottom of container. If it has, note it as non-channeling; if not, note it as channeling.

A-4.5 Reporting

Report the result as channeling of non-channeling.

ANNEX B

(*Clause* 4.2.2.1)

HOMOGENEITY AND MISCIBILITY TEST

B-1 GENERAL

This test determines whether an oil is and will remain homogenous and whether it is miscible and be stable when blended with certain standard oils after being submitted to a prescribed cycle of temperature changes.

B-2 SAMPLE

B-2.1 Test Sample — Approximately 300 ml.

B-2.2 Standard Reference Oils — As approved by the qualifying authority.

B-3 APPARATUS

B-3.1 Test Jar — of clear glass, cylindrical form, flat bottom, approximately 30 to 35 mm in inside diameter and 115 to 125 mm in height.

B-3.2 Thermometer — −50°C to +50°C range, conforming to ASTM E_1 -67 or equivalent.

B-3.3 Cork — to fit the test jar, bored centrally to take the test thermometer.

B-3.4 Jacket — Glass or metal, water-tight, of cylindrical form, flat bottom, about 115 mm in depth, with inside diameter 9.5 to 12.5 mm greater than the outside diameter of the jar.

B-3.5 Disk — Cork or felt, 6 mm in thickness of the same diameter as the inside diameter of the jacket.

B-3.6 Gasket — A ring gasket, about 5 mm in thickness, to fit snugly around the outside of the test jar and loosely inside the jacket. The purpose of the ring gasket is to prevent the test jar from touching the jacket.

B-3.7 Bath — A cooling bath of a type suitable for obtaining the required temperature.

B-4 PROCEDURE

B-4.1 Shake oil sample well and pour into six sample jars to the 37.5 mm mark and one sample jar to the 75 mm. Add a reference oil to each of the sample jars to the 75 mm mark. Mix the oil thoroughly and heat to 46°C in a water bath. After the oils reach room temperature, observe and record the colour and evidence of separation. Determine and record the pour point of each oil.

B-4.2 Maintain the temperature of the cooling bath at −1°C to + 2°C. Support the jacket, containing the test jar, firmly in a vertical position in the cooling bath so that not more than 25 mm of the jacket projects out of the cooling medium.

B-4.3 Beginning at a temperature 12°C before the expected pour point, at each test thermometer reading that is a multiple of 3°C, remove the test jar from the jacket carefully and tilt it just enough to ascertain whether there is a movement of the oil in the test jar. The completed operation of removal and replacement shall require not more than 3 seconds. If the oil has not ceased to flow when its temperature has reached 10°C, place the test jar in the jacket in a second bath maintained at a temperature of −18°C to −15°C. If the oil has not ceased to flow when its temperature has reached −7°C, place the test jar in the jacket in a third bath maintained at a temperature of −34.5°C. For determinations of very low pour point, additional baths should be maintained with successively lower temperature differentials of about 17°C. In each case transfer the test jar when the temperature of the oil reaches a point of 28°C, above the temperature of the new bath. At no time place the cold test jar directly in the cooling medium. As soon as the oil in the test jar does not flow when the jar is tilted, hold the test jar in a horizontal position for exactly 5 seconds, as noted by a stop-watch or other accurate timing device, and observe carefully. If the oil shows any movement under these conditions, place the test jar immediately in the jacket and repeat a test for flow at the next temperature 3°C lower.

B-4.4 Continue the test in this manner until a point is reached at which the oil in the test jar shows no movement when the test jar is held in a horizontal position for exactly 5 seconds. Certain lubricating oils tend to move as a whole and should be very closely observed. Record the reading of the test thermometer at this temperature, corrected for error, if necessary. Allow the samples to thaw; and when the cloudiness has barely disappeared, observe and record the colour and evidence of separation. When the samples reach room temperature, place them in an oil-bath after removing the thermometers. Heat the bath at 230°C and immediately remove the sample jars. Cork the samples and store them at their respective pour points for 18 to 24 hours. Remove the jars and allow the sample to thaw.

When cloudiness has barely disappeared, observe and record the colour and evidence of separation. Repeat the last operation when the samples reach room temperature.

B-5 REPORTING

B-5.1 Report evidence of separation in the following four successive stages:

a) Initial sample;

b) Warmed to just above cloud point after having once reached pour point;

c) After a cycle of heating to 230°C cooling to pour point, storing it for 24 hours at this temperature and warming to just above pour point; and

d) Warmed to room temperature.

B-5.2 Evidence of separation is to be reported as:

a) *Condition*
   i) Definite
   ii) None or doubtful

b) *Location*
   i) Near top
   ii) Near bottom
   iii) Filament
   iv) Uniformly distributed

c) *Particle Size*
   i) Small, as in cloud or haze
   ii) Specks or larger particles

d) *Colour*
   i) White or very light
   ii) Yellow
   iii) Black

ANNEX C
(*Clause* 4.2.2.2)

COMPATIBILITY TEST

C-1 GENERAL

This method is used for determining the compatibility of universal gear lubricant when blended with a reference gear lubricant by observing for precipitation of additive material after storage.

C-2 APPARATUS

C-2.1 100 ml cone-shaped centrifuge tubes.

C-2.2 Centrifuge with a diameter of swing (tip-to-tip of whirling tubes) 375 mm to 425 mm and shall be capable of being controlled at a speed of 1 500 ± 25 rpm.

NOTE — If the available centrifuge does not conform dimensionally to the preferred form, the speed of rotation of the available centrifuge must be adjusted to given the same centrifugal force at the tips of the tubes as that obtained with the prescribed instrument when operated at 1 500 ± 25 rpm. The speed to operate the available centrifuge shall be calculated from the formula:

$$\text{rpm} = \sqrt{\frac{16}{d}} \times 1\,500$$

where, d = the diameter of the swing (tip-to-tip of whirling tubes) of the available centrifuge.

C-2.3 Balance capable of weighing to 1 mg.

C-2.4 Constant temperature bath capable of being controlled at 121° ± 1°C (250° ± 2°F).

C-2.5 Stirring apparatus capable of stirring the contents of a 400 ml tall form beaker at approximately 200 rpm.

C-2.6 Beaker, 400 ml capacity, tall form, heat resistant glass.

C-2.7 Forced circulation oven capable of being controlled at 104.4 ± 2°C (220° ± 5°F).

C-2.8 Desiccator, capable of holding several centrifuge tubes.

C-2.9 Graduated cylinders, 100-ml capacity.

C-3 MATERIALS

C-3.1 Naptha

C-3.2 Cleaning solution, consisting of concentrated sulphuric acid saturated with potassium dichromate.

C-3.3 Distilled Water

C-3.4 Denatured Ethyl Alcohol

C-3.5 Reference Oils — As approved by the qualifying authority.

C-4 PROCEDURE

C-4.1 Make two compatibility tests with each reference oils.

C-4.2 Determine the residue in each of the reference oils and the sample oil by subjecting each of the reference oils alone (not mixed with any other oil) to the procedures described in **C-4.7** through **C-4.16**. This data will be used in calculations of compatibility (**C-4.17.1**).

C-4.3 Preparation of Centrifuge Tubes

Prepare two centrifuge tubes for test with each reference oil.

C-4.4 Support the centrifuge tubes in an inverted position in an oven maintained at 104.4 ± 1°C (220° ± 2°F) for at least one-half hour.

C-4.5 Remove the tubes from the oven, place them in a desiccator, and permit them to cool to room temperature.

C-4.6 Number each tube, weigh to the nearest milligram, and replace tubes in the desiccator until they are to be used.

C-4.7 Thoroughly shake sample and reference oils prior to sampling.

C-4.8 Use 110 ml of reference and test oils.

C-4.9 Heat the beakers containing the reference and test oils in an oven at 121.1 ± 1°C for 20 minutes. Remove the beakers from the oven and stir (with a mechanical stirrer) the contents while still hot for 5 minutes.

C-4.10 Transfer 100 ml of the contents of each beaker to weighed centrifuge tubes. Save the remainder of the oil mixture.

C-4.11 Cork the centrifuge tube and store it in an upright position in a darkened area such as a drawer or cupboard at room temperature for a period of 30 ± 1 days.

C-4.12 At the conclusion of the storage period, remove the centrifuge tube from the storage area, place it in the centrifuge, and operate the centrifuge at 1 500 ± 25 rpm for a period of 30 ± 1 minutes.

NOTE — In transferring the centrifuge tube from the storage area to the centrifuge, care must be taken not to disturb any material which may have separated from the oil.

C-4.13 Remove the centrifuge tube from the centrifuge and decant and discard the supernatant oil. Permit the centrifuge tube to drain in an inverted position at room temperature for a period of two hours. Discard the drainings. If the residue is a solid, wash it with naphtha sufficient number of times to ensure that it is free of oil.

NOTE — If the separated material is not sufficiently compacted by the centrifuging to permit decanting the supernatant oils, continue the centrifuging for 15 minutes intervals until decanting is possible. If the material is a liquid at the conclusion of 30 minutes centrifuging period, or if it can not be compacted, stopper the centrifuge tube and replace it in storage for an additional 30 days. At the end of the second storage period, proceed as directed in C-4.12.

C-4.14 Place the centrifuge tube in an upright position in an oven controlled at 104.4° ± 1°C (220 ± 2°F) for approximately 2 hours.

C-4.15 Remove the centrifuge tube from the oven and place it in a desiccator to cool to room temperature. Weigh the tube and contents to the nearest milligram. Substract the weight of the empty centrifuge tube to determine the weight of the separated material.

NOTE — If the residue remains a liquid at the end of the second 30 days storage period, centrifuge the tube as specified in C-4.12. Remove the tube from the centrifuge and note the volume of the separated liquid to the nearest 0.05 ml.

C-4.16 Pour the remainder of the oil remaining in the 400 ml beaker (approximately 100 ml, *see* C-4.9) into a second 400 ml beaker and examine the beaker in which the oils were mixed for sludge or other evidence of incompatibility.

C-4.17 Report

Calculate the percent incompatibility for each reference oil as an average of the values obtained for each reference oil using the following formula:

Theoretical zero incompatibility = $R + T$

Evidence of incompatibility = $X - (R + T)$

$$\text{Percent incompatibility} = \frac{X - (R + T)}{0.9\,(50\,r + 50\,t)} \times 100$$

where

R = weight of separated material in reference oil (g/50 ml of oil). *See* C-4.2.

T = weight of separated material in sample oil (g/50 ml of oil). *See* C-4.2.

X = weight of separated material found in compatibility test. *See* C-4.16.

r = weight percent of additive in reference oil (to be supplied by the supplier of the refrence oil).

t = weight percent additive in sample oil (to be supplied by the manufacturer of the sample oil).

0.9 = assumed specific gravity of both reference oil and sample.

NOTE — It may be of interest to make a chemical analysis of the residue found in the incompatible oil mixture.

ANNEX D

(*Clause* 4.2.3)

DETERMINATION OF STORAGE STABILITY

D-1 GENERAL

This method is used for determining the storage solubility characteristics of universal gear lubricants.

D-2 APPARATUS

D-2.1 100 ml cone-shaped centrifuge tubes.

D-2.2 Centrifuge with a diameter of swing (tip-to-tip whirling tubes) 375 to 425 mm and shall be capable of being controlled at a speed of 1 500 ± 25 rpm.

NOTE — If the available centrifuge does not conform dimensionally to the preferred form, the speed of rotation of the available centrifuge must be adjusted to give the same centrifugal force at the tips of the tubes as that obtained with the prescribed instrument when operated at 1 500 ± 25 rpm. The speed to operate the available centrifuge shall be calculated from the formula:

$$\text{rpm} = \sqrt{\frac{16}{d}} \times 1\,500$$

where, d = the diameter of the swing (tip-to-tip whirling tubes) of the available centrifuge.

D-2.3 Balance capable of weighing to 1 mg.

D-2.4 Constant temperature bath capable of being controlled at 121° ± 1°C (250° ± 2°F).

D-2.5 Forced circulation oven capable of being controlled at 104.4° ± 1°C (220° ± 2°F).

D-2.6 Desiccator, capable of holding several centrifuge tubes.

D-3 MATERIALS

D-3.1 Naphtha

D-3.2 Cleaning solution, consisting of concentrated sulphuric acid saturated with potassium dichromate.

D-3.3 Distilled Water

D-3.4 Denatured Ethyl alcohol

D-4 PROCEDURE

D-4.1 Preparation of Centrifuge Tubes — Prepare three centrifuge tubes.

D-4.2 Support the centrifuge tubes in an upside down position in an oven maintained at 104.4° ± 1°C (220° ± 2°F) for at least half an hour.

D-4.3 Remove the tubes from the oven, place them in a desiccator, and permit them to cool to room temperature.

D-4.4 Number each tube and weigh it to the nearest milligram.

D-4.5 Place 320 ml of the sample into a 400 ml beaker and heat in an oven at 121° ± 1° (250° ± 2°F) for 20 minutes.

D-4.6 Remove the beaker from the oven and allow it to cool to 25° ± 3°C. Place 100 ml of oil from the beaker in each centrifuge tube and cork the tube. Place the tubes in an upright position, still corked, in a darkened area such as a drawer or cupboard at room temperature for a period of 30 ± 1 days.

D-4.7 Remove the tubes from the storage area, place them in a centrifuge at 1 500 ± 25 rpm for a period of 30 ± 1 minute. If the residue is a solid, wash it several times with naphtha, a sufficient number of times to assure that it is free of oil.

NOTE — In transferring the centrifuge tubes from the storage area to the centrifuge, care must be taken not to disturb any material which may have separated from the oil.

D-4.8 Remove the centrifuge tubes from the centrifuge and decant and discard the supernatant oil. Permit the centrifuge tube to drain in an upside down position at room temperature for a period of two hours.

NOTE — If the separated material is not sufficiently compacted by the centrifuging to permit decanting the supernatant oil, continue the centrifuging for 15 minute intervals until decanting is possible. If the material is a liquid at the conclusion of the centrifuging period, or if it cannot be compacted, cork the centrifuge tube and replace it in storage for an additional 30 days. At the end of the second storage period, proceed as in D-4.7.

D-4.9 Place the centrifuge tubes in an upright position in an oven controlled at 104.4° ± 1°C (220° ± 2°F) for approximately two hours.

D-4.10 Remove the centrifuge tubes from the oven and place them in a desiccator to cool to room temperature. Weigh the tubes and contents to the nearest milligrams. Subtract the weight of the empty centrifuge tubes to determine the weight of the separated material.

D-4.11 If the residue remains a liquid at the end of the second 30 days storage period, centrifuge the tubes as specified in D-4.7. Remove the tubes from the centrifuge and note the volume of the separated liquids to the nearest 0.05 ml.

D-4.12 Calculation

D-4.12.1 Calculate the average amount of separated residue (solid/liquid) on the basis of three test samples.

D-4.12.2 Calculate the percent insoluble residue in the sample from the formula:

$$\text{Percent insoluble residue} = \frac{\text{Average amount of separated residue, g}}{0.9 \times \text{Weight percent of additive in sample}} \times 100$$

where

0.9 = assumed specific gravity of the sample.

NOTE — The weight percent of additive in the sample to be obtained from the manufacturer of the sample.

ANNEX E
(*Clause* 5)

PROCEDURE FOR QUALIFICATION APPROVAL

E-1 PROCEDURE

E-1.1 The oil shall be qualified in accordance with the provisions of this standard. The authority for recommending a qualification approval vests in the 'Panel for Engine and Gear Oil Qualification Approval' PCD 4 : P2.

E-1.2 The Panel for Engine and Gear Oil Qualification Approval has the following functions:

a) Approval of engine/performance test facilities of laboratories for the purpose of recognizing them to carry out engine/performance test evaluation as required by this standard.

b) Approval of blending and quality control facilities of lubricant manufacturers for the purpose of ensuring their ability to manufacture qualified lubricants within the tolerance limits stipulated by this standard.

c) Scrutiny of laboratory test data including evaluation of test components for the purpose of assessing whether the candidate lubricant formulation meet the requirements of the standard and accordingly recommend for or against qualifying the products.

E-1.3 Candidate oil companies desirous of obtaining the qualification approvals of their products against this standard, shall apply to the Bureau of Indian Standards in prescribed form which requires disclosures of full particulars of the formulation in terms of both base stocks and additive components. Such applications should be addressed as confidential documents to the designated official of the Bureau of Indian Standards. The information contained therein shall be treated in strict confidence and not disclosed to any person or organizations, unless so authorized in writing by the candidate oil company.

E-1.4 On receipt of the application for qualification approval, the Bureau of Indian Standards will communicate to the oil company the quantities and mode of despatch of the candidate oil and its components. Finished lubricant blends in requisite quantities under suitable code will be sent to approved testing laboratories for performance evaluation with their prior concurrence of the laboratory.

E-1.5 The testing laboratory shall present the results of all the performance tests and other related data in the prescribed form together with specified components or their photographs at a scheduled meeting of the Panel for engine and gear oil qualification approval.

E-1.6 The Panel based on an overall review of the test data and the condition of the components, shall decide by consensus whether the candidate oil formulation meets the requirements of this standard and accordingly communicate its decision to Bureau of Indian Standards.

E-1.7 In the event of the panel recommending qualification approval, the following documents shall be issued by BIS for extending coverage under BIS Certification Marks Scheme:

a) *Qualification Certificate* — Testifying to the quality of the product and giving it a qualification number. The qualification certificate shall consists of particulars of various components used in lubricant formulation and details of its compliance to relevant physico-chemical performance and other tests.

b) *Product Identification Report* — In which the composition of the product is declared and certain tests data (*see* **16**) are given whereby it is possible to identify the product.

E-1.8 At any time if there is a change in the base stock or base stock sources (as identified by the broad geographical classification such as Indian, Middle-East, Mid-Continent, South-East, Gulf, etc) refining treatment or additives used in the formulation, requalification will be required. Where the proposed changes are minor, the panel may at its discretion recommend waiving complete requalification or may require only partial requalification of the proposed changes.

E-1.9 If a candidate oil company submits a series of viscosity grades for qualification, the performance test will be carried out only on SAE 90 or SAE 80W-90

grades provided the type and dosage of additive in the other grades are identical. The oil company shall file an affidavit to this effect, and the panel will qualify the complete series of oils provided the performance tests are met by the SAE 90 or 80W-90 grade.

E-1.10 In the event the candidate lubricant formulation is found to be marginally failing in some performance tests, the candidate oil company may disclose its formulation particulars to the panel and request it to consider the possibility of a modified formulation meeting the requirements of this standard. In such event, the panel may at its discretion, suggest limited re-evaluation of the modified formulation. On the basis of such re-evaluation the panel may consider recommending qualification approval to the modified formulation.

E-1.11 The oil once approved against this standard will be qualified for a period not exceeding 5 years from the date of the original qualification. When the qualification period has expired each product shall be requalified if the manufacturer wishes to maintain the formulation as a current product meeting this standard.

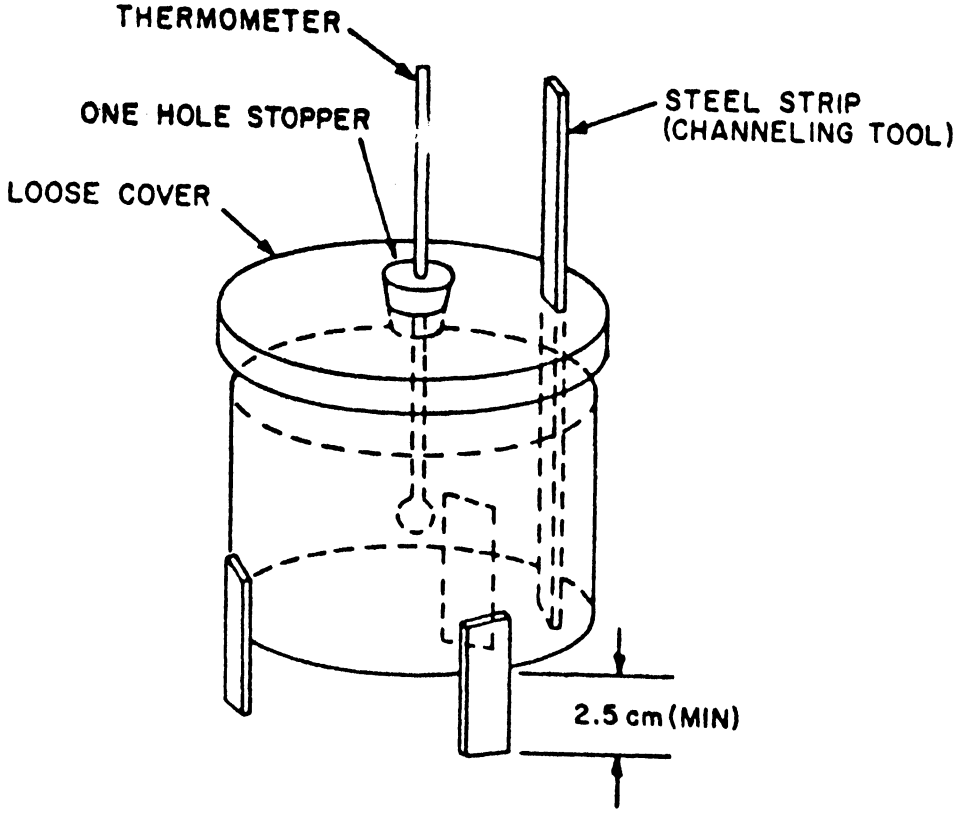

FIG. 1 TEST SETUP

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act, 1986* to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards Monthly Additions'.

This Indian Standard has been developed from **Doc : No. PCD 4 (515)**

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Printed at Simco Printing Press, Delhi